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Role of alfalfa in natural environment

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Abstract

The Alfalfa deep rooting pattern is highly beneficial to hold soil in place. A canopy of alfalfa quickly covers the soil, protecting the soil from wind and water erosion. The dense vigorous alfalfa canopy shades these weeds and frequent cutting prevents weed seed production. Many crops must be cultivated several times per year to remove weeds. One of the key values of alfalfa is its ability to 'fix' nitrogen gas (N_2) from the air so that N is available for plant growth. Available N is very limited in the Earth's crust and is frequently deficient in plants. Nitrogen is a basic building block for plant proteins, and for human protein nutrition. Alfalfa canopies provide an effective cover for many species for feeding, sleeping, nesting, or escaping predators. There is a wide range of insects, both herbivores and predators that are present in large populations in alfalfa fields. High water absorption and deep roots also make it a valuable crop to manage water tables. Roots can efficiently degrade petroleum products and carcinogenic polynuclear aromatic hydrocarbons. Alfalfa can be used for the effective recycling of many different types of organic wastes. It is naturally derived and an evolved product of the Earth, the benefits that arise from using it are abundant. The alfalfa plant is naturally high in many essential vitamins (A, D, E, vitamin B) and minerals.

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Introduction

Alfalfa was associated with the horse the name 'alfalfa' comes from Arabic, Persian, and Kashmiri words meaning 'best horse fodder' and 'horse power' (Dan *et al*., 2001). The geographic center of origin often mentioned as the home of alfalfa is Iran (Majid, 2008). More than 6,000 year old remains of alfalfa have been found in Iran, and the oldest written reference for alfalfa is from Turkey in 1300 BC (Petr, 2015). Many farmers and cultures value its high productivity, wide adaptation, and life-sustaining nutritional characteristics. Alfalfa is one of the world's most versatile crops. It is grown in environments ranging from burning hot deserts to cool high mountain valleys (Haresh, 2013). Alfalfa has tremendous genetic resistance to many pests, a result of traditional plant breeding (Elizabeth *et al*., 2008). Consequently, alfalfa does not need a large amount of pesticides each year compared with other crops. However, there is a large benefit from controlling insect and weed pests of alfalfa in new and established alfalfa stands using integrated pest management techniques. Key insect pests include alfalfa weevil, leafhoppers, alfalfa caterpillar, armyworms, and many types of aphids. Weeds can be a major problem, especially during stand establishment. Weeds can severely reduce the nutritional quality of alfalfa, but a vigorous alfalfa stand is highly resistant to weed infestation (Charles, 1998).

Deep root of alfalfa holds soil

Alfalfa's roots go much deeper than other crops. This deep rooting pattern is highly beneficial to soils. Alfalfa roots are commonly 9 - 16 feet (3 - 5 meters) and may extend much deeper. The deep, vigorous alfalfa root system holds the soil in place and creates many channels in the soil that encourage water infiltration, biological activity in the root zone, and improved nutrient cycling. Water use efficiency may be improved subsequent crops (Junying *et al*., 2009).

Vigorous canopy protect the soil

A canopy of alfalfa quickly covers the soil, protecting the soil from wind and water erosion. Unlike row crops, alfalfa covers most parts of the soil, slowing water droplets before they have a chance to loosen and erode the soil. The amount of soil or water that runs off alfalfa fields is a small fraction of the runoff from bare soil or from many other types of cropland. This helps prevent pesticide and sediment movement to natural waterways. (Dabney *et al*., 2007).

Alfalfa prevents weeds

Alfalfa fulfills a very important role in crop rotations by suppressing weeds that are common in annual crops. The dense vigorous alfalfa canopy shades these weeds and frequent cutting prevents weed seed production. This could reduce pesticide use in subsequent crops (Eric *et al*., 2013).

Alfalfa prevents erosion

The soil erosion has always been a significant environmental hazard of agriculture. Soil erosion is a permanent loss of productive potential, since the most fertile soil layers erode, only to pollute streams and lakes with sediment. Alfalfa protects the soil from erosion by reducing the amount of cultivation, by holding the soil in place through extensive rooting, by providing a vigorous above-ground canopy, and by improving 'tilth' and water penetration (Kristen *et al*., 2009).

Alfalfa reduced cultivation

While many crops must be cultivated several times per year to remove weeds while little soil disturbance occurs in alfalfa fields after the crop is established. Most alfalfa fields are never tilled for 3-6 years after planting. This greatly reduces the chances of wind and water erosion, and lessens the negative effects of dust on human health (Helmut *et al*., 2010).

Alfalfa requires pesticides

Alfalfa sometimes requires herbicides and insecticides for optimum crop production, but the intensity of pesticide use in alfalfa is typically far lower than many other crops, particularly the 'higher value' crops. This lowers the overall risk of crop production to the environment (Stephen *et al*., 2012).

Rhizosphere of Alfalfa

Alfalfa roots produce an excellent environment for growth of microorganisms immediately surrounding the root (the rhizosphere). This flurry of biological

activity is due to natural chemical exudates from roots, but also to the nitrogen and carbon in dead and dying roots and root nodules (Gary and Norman, 2019) Microorganism populations are usually 10 to 100 times higher next to the root than in the bulk soil. The alfalfa 'rhizosphere' is very important environmentally and is beneficial to the soil. Organic acids produced in the rhizosphere improve the structure of the soil surrounding alfalfa roots. Soil particles aggregate, creating pore space for air and water movement. The soil becomes 'crumbly' leaving many 'channels' – ideal for plant growth and water infiltration. Farmers the world over recognize the beneficial effect of alfalfa on the soil and the following crop (Michelle *et al.*, 2006).

Alfalfa fixes nitrogen

One of the key values of alfalfa is its ability to 'fix' nitrogen gas (N_2) from the air so that N is available for plant growth. Available N is very limited in the Earth's crust and is frequently deficient in plants. Nitrogen is a basic building block for plant proteins, and for human protein nutrition (Miriam, 2019). While cereal crops require millions of tons of N fertilizers per year. The alfalfa requires essentially no N fertilizers for optimum growth. Estimates for N_2 fixation in alfalfa range from 120 to 540 lbs of N per acre per year. N_2 fixation is accomplished by symbiotic association with the bacteria *Sinorhizobium meliloti*, which lives in nodules in alfalfa roots. Dinitrogen fixation by alfalfa has several important environmental benefits, which are not broadly recognized (Jennifer *et al.*, 2007).

Perennially of Alfalfa

Alfalfa fields represent a stable, relatively undisturbed area where plant growth continues throughout the year, unlike other sites that are either disturbed, or exhibit only seasonal growth (Andrew and Karen, 2019).

High feeding value of Alfalfa

The high palatability of alfalfa, which makes it such a good dairy feed, also makes it desirable to many herbivores, including many species of insects, rodents and grazing animals (Russell and Micheal, 1992).

Alfalfa covers many species

Alfalfa canopies provide an effective cover for many species for feeding, sleeping, nesting, or escaping predators (Dan *et al.*, 2001).

Insect diversity

There is a wide range of insects, both herbivores and predators that are present in large populations in alfalfa fields (John and Robert, 1998).

Alfalfa requires frequent irrigations

The presence of irrigation water in alfalfa fields during hot periods is important to wildlife species as well as to the crop. In some environments, alfalfa irrigations are a welcome respite for thirsty animals. Irrigation also flushes insects and rodents to the surfaces, which are food sources for birds, snakes, and raptors, such as eagles and hawks. Irrigation and a closed canopy creates a humid microclimate desirable for insects and bird eggs (Suat *et al.*, 2007).

Alfalfa requires open spaces for hunting

Raptors are frequently found soaring above alfalfa fields, or awaiting prey from nearby posts. Some growers have planted trees, provided raptor poles, or built owl boxes to encourage raptor habitat in an otherwise horizontal landscape. Around the field margins animals can easily find trees, shrubs and weeds in which to nest, coupled with access to a plentiful supply of water nearby (Messmer, 1999).

Alfalfa preventing nitrate leaching

Alfalfa, more than most other crop species, has the ability to intercept nitrates from the soil. Sources of nitrate may be fertilizers, manures, industrial spills, or natural sources. Nitrate (NO_3) is highly soluble, and moves with rainwater or irrigation water, and can contaminate groundwater, wells, streams, or estuaries. Nitrates can cause health problems in humans and animals, and adversely affect ecosystems (Katharina *et al.*, 2012). These problems may be prevented or alleviated using alfalfa. Alfalfa's ability to 'scrounge' nitrate is partially due to its ability to extract water. Alfalfa recovers most of the water in the root zone, and since most of the nitrate is dissolved in the soil water, the plant intercepts it. Alfalfa has an

outstanding ability to absorb nitrate from the soil solution. If concentrations in the soil are kept low by alfalfa, even large losses of water from the root zone will not contaminate groundwater aquifers (Read and Jensen, 1989).

Alfalfa protecting estuaries &surface water

Reducing losses of nitrate in tile drainage water is extremely important for protection of surface water quality and the health of estuaries. In tile drained fields both alfalfa and a grass/alfalfa mixture kept annual nitrate-N losses in tile drainage to less than 5lb/acre. While losses under continuous corn or corn/soybean rotations averaged over 40lb/acre (Suresh and Indrajeet, 2017).

Alfalfa managing water tables

Alfalfa's high water absorption and deep roots also make it a valuable crop to manage water tables. Alfalfa in rotations with annual crops to help reduce water table levels. Alfalfa is also commonly used in the Delta region and as well as in locations of saline seeps. The specific hydrologic and chemical conditions at each site will determine whether alfalfa can be used for this purpose (Khaled *et al.*, 2001).

Removing carcinogens from the soil

The 'rhizosphere' of soil and organic compounds surrounding the root is very important environmentally. There is good evidence that the organisms around alfalfa roots can efficiently degrade petroleum products and carcinogenic polynuclear aromatic hydrocarbons (PAHs). At one site, a standard alfalfa cultivar reduced PAH concentration by over 70%. Genetic engineering may improve this capability (Martina and David, 2009).

Uptake of contaminants

If heavy metals are a problem in soils, alfalfa may be able to absorb them and depending upon the concentration in the forage. The harvested forage can then be fed or incinerated. Alfalfa has been used to mitigate perchlorate contamination in water, a result of the manufacture of rocket fuel. Researchers have also begun to develop alfalfa that can absorb and breakdown atrazine, a widely used herbicide sometimes found contaminating well water. A team of researchers have found a *Pseudomonas bacterium* that decomposes atrazine to harmless byproducts. After moving the bacteria's naturally occurring gene into alfalfa, they developed a plant that takes up 3 times as much atrazine as normal alfalfa. They hope this alfalfa can play a role in preventing and cleaning up water contamination (Ana, 2014).

Recycling of wastes

A wide range of organic waste products can be recycled using alfalfa. Many of these 'waste' products are, in fact, fertilizers, if used properly. Alfalfa is commonly used in many locations to recycle dairy manures. In other areas, alfalfa is used for municipal waste recycling. Although careful monitoring of heavy metals and biological compounds may be necessary, alfalfa can be used for the effective recycling of many different types of organic wastes (Giovanni, 2011).

Lowering particulates in air

Dust is a common hazard of farming and industry. Health professionals are concerned with PM10 particles since they are smaller than 10 microns and can lodge in the human lung, causing health problems. Alfalfa contributes greatly to limiting particulates released into the air. Alfalfa releases only a small fraction of the particulates that are released from other agricultural and non-agricultural activities. Furthermore, the vigorous canopy prevents movement of dust out of fields due to windstorms, and traps fugitive dust from other areas (Dan *et al.*, 2004).

Alfalfa naturally exchanges CO_2

Human activities like deforestation, intensive animal husbandry and fossil fuel burning are responsible for the considerable increase in atmospheric CO_2 over the last 150 years that it is expected to continue during the following decades. As a perennial crop, alfalfa fixes significant quantities of CO_2 through photosynthesis. A portion of this carbon is retained in the thick root structure and in the rhizosphere surrounding the root. An alfalfa crop helps to temporarily retain carbon, both in the plant biomass

and the soil rhizosphere, potentially lessening the effects of global warming. An alfalfa field naturally exchanges the CO_2 with oxygen, which freshens the surrounding atmosphere (Stephane *et al.*, 2010).

Antioxidant activity of Alfalfa

Alfalfa has a long history of use as medicine to treat conditions caused by inflammation and oxidative damage. This is because alfalfa was thought to act as a powerful antioxidant, preventing damage caused by free radicals. Several animal studies have now confirmed its antioxidant effects. They found that alfalfa has the ability to reduce cell death and DNA damage caused by free radicals. It does this by both lowering the production of free radicals and improving the body's ability to fight them (Bora, 2011).

Nutritional benefits of alfalfa for humans

When something is naturally derived and an evolved product of the Earth, the benefits that arise from using it are abundant. The alfalfa plant is naturally high in many essential vitamins, including A, D, E, K, and even the full family of B vitamins. Each individual vitamin has an abundance of health benefits in itself, making them crucial to overall human health. It is also loaded with extremely important minerals such as biotin, calcium, folic acid, iron, magnesium, potassium, and many others. The alfalfa plant has an unusual, extensive root system that can reach as far as 60 feet into the soil. The alfalfa herb is believed to have a direct connection to lowering cholesterol, which is once again in direct connection with all of the positive vitamins and minerals it contains. The alfalfa herb is very good at detoxifying and better purifying the blood. Consuming alfalfa herb on a routine basis has an abundance of positive health results (Yong-Han, 2009).

Nutritional benefits of Alfalfa for animals

Alfalfa was regarded as a highly nutritious animal feed and it is preferred to other forages in feeding ruminants. The demand arises because its primary nutritive values is based on rapid passage through gastrointestinal tract. The large amount of soluble protein provided for rumen microorganisms for resyntesis of protein, synthesis of B vitamins and stimulation of cellulose digestion. The value of vitamin A, E and K or their precursor all of which are vital protective nutrients when alfalfa forages are fed to dairy cattle and the fact that alfalfa has relatively large amounts of cell soluble and lowest amount of cell walls in comparison with other forages (Radovic, 2009).

Conclusion

Alfalfa is a perennial plant of spring or fall. And Alfalfa harvested for many years. The seedbed is usually prepared finely to cover the seed, but some growers seed alfalfa without tillage, directly into stubble. After developing a 'crown' (top of the root), alfalfa is very vigorous, and can re-grow many times after cutting. Alfalfa breeders have developed many varieties of alfalfa that are highly resistant to diseases and insect pests, thereby reducing the need for pesticides. Alfalfa has tremendous genetic resistance to many pests, a result of traditional plant breeding. Consequently, alfalfa does not need a large amount of pesticides each year compared with other crops.

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